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(54) [Title of the Invention] MUSICAL SOUND PARAMETER CONTROL UNIT

(57) [Abstract] (Revised)
[Problem to be Solved] To provide a parameter control unit which controls all of tempo, tone, length, etc. to realize musical expressions.
[Solutions] The detected value of a swing sensor 2 provided on a swing control 1 is input to a characteristic extracting means 3. The characteristic extracting means 3 extracts the change of the value or the characteristic of the output waveform of the swing sensor 2. A playing means 4 outputs musical sound parameters. An musical sound parameter controlling means 5 controls the parameters input from the playing means 4 based on the characteristic of the waveform input from the extracting means 3. For example, in case that the peak sharpness of the swing speed is used for controlling the speed of starting a sound or the period of it being produced, the sound start is delayed or the

playing time of a note is extended to realize a legato articulation when the control element 1 is smoothly moved. When the swing control 1 is moved clearly and sharply, on the other hand, the sound start is advanced or the playing time of a note is shortened to realize a staccato articulation. As mentioned above, musical expressions matching swings can be achieved.

[Claims]

[Claim 1] A musical sound parameter control unit characterized by comprising:

a playing means for outputting musical sound parameters;

a swing control provided with a swing sensor;

a character extracting means for extracting the characteristic of the waveform output from the swing sensor; and

a musical sound parameter controlling means for controlling the musical sound parameters based on the characteristic extracted by the character extracting means.

[Claim 2] An musical sound parameter control unit characterized by comprising:

an automatic playing means for sequentially reading automatic play data including musical sound parameters;

a swing control provided with a swing sensor;

a beat timing detecting means for detecting beat timings from the output waveform of the swing sensor;

a character extracting means for extracting the characteristic of the waveform output from the swing sensor;

a tempo controlling means for controlling tempo by reading automatic play data based on the beat timings which the beat timing detecting means detects; and

an musical sound parameter controlling means for controlling the musical sound parameters based on the characteristic extracted by the character extracting means.

[Claim 3] An musical sound parameter control unit characterized by comprising:

an automatic playing means for sequentially reading automatic play data including musical sound parameters;

a swing control provided with swing and gripper sensors;

a beat timing detecting means for detecting beat timings from the

output waveform of the swing sensor;

a tempo controlling means for controlling tempo by reading automatic play data based on the beat timings which the beat timing detecting means detects; and

an musical sound parameter controlling means for controlling the musical sound parameters based on the value output from the gripper sensor.

[Detailed Description of the Invention]

[0001]

[Technical Field Belonging to the Invention] The present invention relates to musical sound parameter control units for controlling the parameters of volume, tone, length, etc. based on the swing of swing controls, such as batons and hand-wave controllers, or the outputs of the sensors provided on these control elements.

[0002]

[Prior Art] A variety of devices, which control musical performances based on operators' actions, has been already proposed. They include a device for controlling tempo in automatic playing by using swing controls, as described in the patent application JP-A-Hei 3-60119.

[0003]

[Problem to be Solved by the Invention] However, there has not been proposed yet the devices capable of controlling volume, tone, length, etc. according to waving actions. During musical performances, the previously proposed devices have not been able to control them while specifying or controlling the tempo by natural actions including waving hands. Therefore, even if users of these devices try to realize musical expressions while controlling tempo, they cannot be sufficiently reflected to the plays.

[0004] An object of the invention is to provide parameter control units, which control all of tempo, volume, tone, length, etc., to realize musical expressions with the use of swing controls.

[0005]

[Means for Solving the Problems] The invention of this application as claimed in Claim 1 is characterized by including: a playing means for outputting an musical sound parameter; a swing control provided with a swing sensor; a character extracting means for extracting the characteristic of the waveform output from the swing sensor; and an musical sound parameter controlling means for controlling the musical sound parameter based on the characteristic extracted by the character extracting means.

[0006] FIG. 1 shows the structure of the invention as claimed in Claim 1. A swing control 1 is provided with a swing sensor 2. Various types of sensors can be used as the swing sensor 2 such as an angular speed sensor which detects an angular speed of actions and an acceleration sensor, which detects acceleration of actions. The detected value of the swing sensor 2 is output to the character extracting means 3. The

characteristic extracting means 3 extracts the change of the value or the characteristic of the waveform output from the swing sensor 2. The characteristic includes a Q value of a peak (value indicating the sharpness of the peak), a derivation, second derivation, integration of the waveform, etc. The playing means 4 outputs musical sound parameters. They include envelope and filter characteristics of musical sounds, modulation amounts such as of vibrato, periods of sound productions (gate times). The musical sound parameter controlling means 5 controls and outputs the musical sound parameters input from the playing means 4 by the characteristic of the waveform input from the extracting means 3.

[0007] For example, a Q value of a peak and a peak value of a derivation is correlated to the sharpness of actions. If this sharpness is used for controlling the speed of starting a sound or the period of it being produced, the sound start is delayed or the playing time of a note is extended to realize a legato articulation when the swing control 1 is smoothly moved. When the swing control 1 is moved clearly and sharply, on the other hand, the sound start is advanced or the playing time of a note is shortened to realize a staccato articulation. As mentioned above, the characteristic of the waveform is properly assigned to the control of the musical sound parameter to realize musical expressions matching the actions of operators. These actions may include one for specifying tempo or other musical expressions.

[0008] The invention of this application as claimed in Claim 2 is characterized by including: an automatic playing means for sequentially reading automatic play data including musical sound parameters; a swing control provided with a swing sensor; a beat timing detecting means for detecting beat timings from the output waveform of the swing sensor; a character extracting means for extracting the characteristic of the waveform output from the swing sensor; a tempo controlling means for controlling tempo by reading automatic play data based on the beat timings which the beat timing detecting means detects; and an musical sound parameter controlling means for controlling the musical sound parameters based on the characteristic extracted by the character extracting means.

[0009] FIG. 2 shows the structure of the invention as claimed in Claim 2. In the figure, the descriptions for the parts overlapping the invention as claimed in Claim 1 are not provided. In this invention as claimed in Claim 2, the detected value of the swing sensor 2 on the

swing control 1 is output to the character extracting means 3 as well as beat timing detecting means 6. The beat timing detecting means 6 detects beat timings specified by the waveform output from the swing sensor 2. Beat timings are specified by the turn-around point of a direction of a tool swing, the peak of the speed, etc. When detecting a beat timing, the beat timing detecting means 6 informs the tempo controlling means 7 of the detection. The tempo controlling means 7 performs reading from the automatic playing means 8 based on the beat timings specified to control the tempo. The musical sound parameters read from the automatic playing means 8 are input to the musical sound parameter controlling means 5 and are controlled based on the characteristic of the waveform output from the swing sensor 2. From these processes, both the tempo of automatic playing and musical expressions can be controlled based on the swing of the swing control 1, realizing an automatic playing control similar to the performance of conductors.

[0010] The invention of this application as claimed in Claim 3 is characterized by including: an automatic playing means for sequentially reading automatic play data including musical sound parameters; a swing control provided with swing and gripper sensors; a beat timing detecting means for detecting beat timings from the output waveform of the swing sensor; a tempo controlling means for controlling tempo by reading automatic play data based on the beat timings which the beat timing detecting means detects; and an musical sound parameter controlling means for controlling the musical sound parameters based on the value output from the gripper sensor.

[0011] FIG. 3 shows the structure of the invention as claimed in Claim 3. In this invention, the swing control 1 is provided with the swing sensor 2 and gripper sensor 9. Various types of sensors may be used as the gripper sensor 9 such as a pressure sensor built in the part of the swing control 1, where an operator grips, for detecting the gripping force, and a variable resistor, which is operated by the fingers of the hand gripping the swing control 1. The output of the gripper sensor 9 is input to the musical sound parameter controlling means 5. The detected value of the swing sensor 2 is input to the beat timing detecting means 6. The beat timing detecting means 6 detects beat timings specified by the waveform output from the swing sensor 2, and informs the tempo controlling means 7 of the detection. The tempo controlling means 7 performs reading from the automatic playing means

8 based on the beat timings specified to control the tempo. The musical sound parameters read from the automatic playing means 8 are input to the musical sound parameter controlling means 5, and are controlled based on the output of the gripper sensor 9. This can control the tempo of automatic playing based on the swing of the swing control 1, while enabling to control the musical sound parameters by the hand holding the swing control 1.

[0012] Additionally, multiple parameters can be controlled by the pressures of the fingers of the hand holding the swing control 1. For example, the pressure of the middle finger controls the modulation amount to control vibrato depth, while that of the annular finger changes a filter cutoff frequency to control a tone. This enables to make a deep vibrato or increase a higher harmonic wave by strongly gripping the swing control 1.

[0013]

[Embodiments of the Invention] FIG. 4 is a block diagram of an automatic play control system of an embodiment of the present invention. This system includes a baton 20, which is a swing control, a microcomputer 21, which analyzes a swing waveform of the baton 20, an automatic playing unit 22, which performs automatic playing based on peak type data that are beat timing signals input from the microcomputer 21, a sound generator circuit 23 which produces musical sounds based on the play information input from the automatic playing unit 22, a digital-to-analog (D/A) converter 24, which converts digital musical sound signals produced by the sound generator circuit 23 to analog signal, and a sound system 25, which amplifies the analog musical sound signal output from the D/A converter 24 to produce sounds.

[0014] Multiple angular speed and/or acceleration sensors facing opposite directions (X and Y directions) are built in the baton 20. The swinging direction of the baton 20 and its angular speed and/or speed is calculated based on the detected value of these sensors. The speed is acquired by integrating the detected value of the acceleration sensor. The "angular speed and/or speed" are referred to as "speed" hereinafter. The microcomputer 21 calculates the swinging direction and speed. The swing controls are not limited to batons. The elements may be grip-type controllers or those that can be directly attached to hands.

[0015] The microcomputer 21 calculates the swinging direction and speed of the baton 20 and analyzes its swing waveform to acquire a beat

timing, beat type, peak level, and legato coefficient. Data related to beat timing and its type are output to the automatic play unit 22 for controlling the tempo of the automatic play data read. Data on a peak level are output to the automatic playing unit 22 for correcting the velocity (parameter for controlling volumes). A legato coefficient is output to the automatic playing unit 22 and sound generator circuit 23 for controlling a gate time, which is a parameter for controlling periods of sound productions, modulations such as vibrato, and parameters of envelope.

[0016] FIG. 7 shows the changes of the absolute speeds v of the baton 20 when conducting with different triple measure expressions as in FIG. 8(A) through (C). FIG. 8 (A) shows a conduction pattern with a non-legato (sounds continued) articulation. In non-legato mode, the speed changes as indicated by the curve (a) in FIG. 7. FIG. 8 (B) shows a conduction pattern with a legato (sounds continued smoothly) articulation. In legato mode, the speed changes as indicated by the curve (b) in FIG. 7. FIG. 8 (C) shows a conduction pattern with a staccato (sounds cut with short intervals) articulation. In staccato mode, the speed changes as indicated by the curve (c) in FIG. 7.

[0017] In staccato mode of FIG. 8 (C), the swing acceleration is large, while the maximum value of the speed is high, as the curve (c) in FIG. 7 indicates. This is due to that crispy and sharp actions are performed for each beat. The shape at the peak is therefore high, resulting in the increase of the Q value indicating the sharpness. The swing always stops at the beat points (beat timing), while the period, during which the absolute speed v=0 or V≈0 is 0, is maintained for long.

[0018] For legato, the curve moves slowly and smoothly as indicated in FIG. 8 (B). The vertical action stops at each beat point (the detected value of the Y-direction sensor ≈ 0). However, the action continues in the horizontal direction (the detected value of the X-direction sensor ≠0), resulting in that the absolute speed v ≠0. As there is little time when the baton 20 stops swings in legato, the maximum value of the absolute speed v is low. The peak shape is gentle, while the Q value is low.

[0019] Non-legato mode shows a characteristic between staccato and legato, as indicated by the curve (a) in FIG. 7.

[0020] As explained heretofore, when specifying legato by continuing sounds smoothly or cutting them with short intervals depending on the swing of the baton 20, the characteristic is indicated by the shape

of swing peaks or the degree of stops at beat points (the time when the absolute speed v =0). In this embodiment, therefore, a legato coefficient leg, which indicates the degree of legato, is calculated based on Q, the value expressing the peak shape (sharpness at the peak).

[0021]

[Formula 1]

$$Q=(peak/2w) \text{ ---------------------------- } (1)$$

$$leg=127\left(1-\frac{Q-Qmin}{Qmax-Qmin}\right) \text{ ----------- } (2)$$

[0022] In the above formula, a symbol w denotes a period between the time, at which a peak is detected, and that, at which a peak value divided by the square root of 2 is detected immediately before that peak. It can be said that, if this period is short, the peak shape is sharp. A Q value is normally acquired by dividing a peak value by the period between the times at which the values immediately before and after the peak is divided by the square root of 2. In this embodiment, however, w is immediately used for calculating Q and a legato coefficient leg when a peak is detected. A peak value is divided by the value with w doubled to acquire Q. Alternatively, an original value of Q may be acquired for a legato coefficient leg.

[0023] Qmax in the above calculation formula is a Q value when the baton 20 is swing in the most staccato mode. Qmin is, on the other hand, is a Q value when the baton 20 is swing in the most legato mode. Qmax and Qmin may be stored beforehand in the microcomputer 21 as fixed values. Conductors may also input them by playing the most staccato and legato modes with the use of the baton 20 before actual performances.

[0024] The method to acquire a legato coefficient leg using Q is not limited to the formula (2) above. Rather than using Q, the coefficient may be acquired based on a derivative value of a speed waveform of the time derivation value immediately before an absolute speed v reaches the peak, as well as its second derivation and integration values. Alternatively, the difference between a dynamic threshold (average value of speed movement) and a peak value can be used. The coefficient may also be acquired based on the shape of a zone where an absolute value v ≈0. This legato coefficient leg is acquired at each peak (or at each zone where an absolute value v ≈0). The coefficient may be used

as is for the control described below. Furthermore, a stabilized value acquired from multiple legato coefficients leg before that and average movements can be used for the control.

[0025] In the description above, a speed v is specified as an absolute value. If the speed v is acquired as an angular speed, the same value results.

[0026] When a legato coefficient leg calculated at each peak is used for controlling musical expressions of automatic playing, the coefficient may also be used for controlling a modulation depth of vibrato etc. It can be used for controlling an EG characteristic by advancing the sound start and end in staccato mode or for controlling a tone to lower a filter cutoff frequency in legato mode. Furthermore, the coefficient can be multiplied to a gate time to control the length of an instrument sound. The gate time in this case means a time when a sound is actually being produced against the written length of notes (step time) such as crotchet and quaver. Normally, however, the gate time is 80 to 90% of the step time. If the gate time approaches 100% (the time may exceed 100%), the sound becomes legato. It becomes staccato if the percentage becomes lower.

[0027] To calculate a gate time, a formula of, for example a corrected gate time = an original gate time × ((leg/127) + 0.15) can be used. A legato coefficient leg is set from 0 to 127. In the above formula, 0.15 is a predetermined offset value. The formula is, however, not limited to the one above.

[0028] FIG. 9 and 10 are flowcharts illustrating the operations of the microcomputer 21. FIG. 9 illustrates the process of loading the output of the sensor built in the baton 20 to detect a peak. This process is executed with a regular timer interrupt operation. This operation is executed at, for example, every 10ms. First, the outputs of the sensors in the X and Y directions are loaded (s1). An absolute speed or absolute angular speed is acquired based on the loaded output values of the sensors (s2). If an acceleration sensor is provided on the baton 20, the detected value is integrated to acquire velocity components of the X and Y directions. These components are then combined using a formula of (■$(X^2 + Y^2)$) to acquire an absolute speed. If an angular speed sensor is provided on the baton 20, the angular speeds in the X and Y directions are combined to acquire an absolute angular speed in the swinging direction. The resulted absolute speed or angular speed in the swinging direction is saved with the time (s3). A peak is then

determined based on multiple absolute speeds or absolute angular speeds saved in a chronological order (s4). When the value of the absolute speed or absolute angular speed increases and decreases afterward, the maximum value of the boundary between the upside and downside zones is determined as a peak. Whether or not a peak is detected is determined at the step s5. If it is not detected, the process terminates. When a peak is detected, a process for determining its type is executed (S6). This process determines what beat and meter the peak is heading.

[0029] The flowchart in FIG. 10 (A) is a detailed diagram of the process to determine a peak type. First, a swing angle is determined at the steps s20 and s21. The angle is, as in FIG.10 (B), calculated in combination with the output values of X- and Y-direction sensors. This flowchart is for the conduction with a triple or binary (quadruple) measure, as described in FIG. 10 (C). If a swing angle is more than 180 degrees but less than 300 degrees, the step proceeds to s22 depending on the determination is s20. At the step s22, a judgment is made that the peak of this time is the first beat. Based on this judgment, the peak type parameter is set to 1. The step then proceeds to s25. If a swing angle is less than 60 degrees but more than 300 degrees (s21), a judgment is made that the peak of this time is the second beat. Based on this judgment, the peak type parameter is set to 2 (s23). The step then proceeds to s25. In case that a swing angle is more than 60 degrees but less than 180 degrees, a judgment is made that the peak of this time is the third beat. Based on this judgment, the peak type parameter is set to 3 (s24). The step then proceeds to s25. At the step s25, the peak type data and the peak value of the time are output and returned.

[0030] Back in FIG. 9, among the saved absolute speeds or absolute angular speeds, the time of detecting a peak value divided by the square root of 2, which is calculated from the time of the peak detection, is searched. A peak width w is then acquired as a period between this time above and the time of the peak detection (s7). Consecutively, Q is acquired based on the peak value and w (s8). In the next step, a legato coefficient leg is calculated based on Q (s9). The resulted coefficient is input to the automatic playing unit 22 and sound generator circuit 23. The calculation method for w, Q, and a legato coefficient leg is can be found in the explanations for FIG. 7 and 8.

[0031] When actually conducting with the baton 20, there may be cases that a speed v≈s 0 at a beat timing (especially the first beat), as described in FIG. 7 and 8. To accurately detect the beat timing, the

peak and beat timing should be separately detected when processing the sensor output as in FIG. 9. For example, the timing, at which the Y-direction speed Vy ≈0, is used as a beat timing.

[0032] FIG. 5 is a block diagram of the automatic play unit 22. Automatic play data are stored in a play data memory 31. The data consist of the following sequences: parameter sets (note-on, note number, velocity, and gate time) related to musical sounds produced, event data consisted of event data specifying beat positions and types, and timing data specifying intervals between each event data. A reading circuit 32 sequentially reads the automatic play data stored in the play data memory 31. A tempo control circuit 30 controls the timing when the reading circuit 32 reads the automatic play data. The tempo control circuit 30 reads peak type data of swing speeds, which are received from the microcomputer 21. If the peak type data is input after reading the beat event data, the tempo control circuit 30 temporarily stops the reading to synchronize the timing. If the data is input before the reading, the circuit immediately performs the reading so as to synchronize the timing. The tempo control circuit 30 also adjusts the reading tempos to match the input intervals of the peak type data. In case that the type (the first beat, second beat, etc.) of the beat event data to be read next differs from the input data, the tempo control circuit 30 stops the reading. This enables the reading of automatic play data to follow the swing of the baton 20.

[0033] The reading circuit 32 sequentially reads automatic play data from the play data memory 31. When event data are read, the circuit outputs parameters including a note-on parameter to the sound generator circuit 23 via a volume correction circuit 34. The reading circuit 32 then counts the gate time. When the count is up, the reading circuit 32 outputs a note off parameter to the sound generator circuit 23. A gate time correction circuit 33 corrects the gate time.

[0034] The gate time correction circuit 33 corrects the gate time of event data read based on a legato coefficient leg, which is input from the microcomputer 21. To correct the time, it is increased when the legato coefficient leg is large and is decreased when the coefficient is small (staccato). The legato coefficient leg is input at each beat. For notes longer 2 beats, however, the coefficient for the first beat may be used to correct the entire gate time, applying the corrected time to the subsequent sounds produced. Alternatively, the legato coefficient leg at each beat may be used to correct the remaining gate

time.

[0035] Based on the peak value received from the microcomputer 21, the volume correction circuit 34 corrects velocities which are parameters included in event data. Velocities are parameters for determining the volumes of musical sounds, the shapes of envelope attacks, etc. To correct velocities, for example, the velocity value is increased when the peak value is large and is decreased when the value is small.

[0036] FIG. 6 is a block diagram of the sound generator circuit. A Wave generator circuit 40 generates waveform signals of musical sounds based on the event data received from the automatic play unit 22. More specifically, these signals of pitches corresponding to the note numbers, which are included in event data, are generated at volumes (amplitudes) according to velocities. When note off signals are input, the waveform signals are transferred to release waveforms, and then go off. Methods of waveform memory, FM, physical model, higher harmonic wave composition, etc. may be used to generate waveforms. Other than specialized hardware software, DSPs and the combination of microcomputers and software are the alternatives.

[0037] A modulator circuit 41 generates pitch modulation signals based on the legato coefficient leg, which is received from the automatic play unit 22. The signals are then provided to the Wave generating circuit 40. This circuit increases or decreases note numbers according to the signals. This fluctuates the pitches of the waveform signals of the musical sounds generated, achieving vibrato effects. As the pitch modulation signals are controlled by the legato coefficient leg, the depth and speed of vibrato can be changed with the swing of the baton 20.

[0038] An envelope generator 43 generates waveform signals of predetermined shapes. They change according to the legato coefficient leg. If the coefficient is large, the attack is gradual and its level is small, while the release is slow. If the coefficient is small, the attack is sharp and large, while the release is short.

[0039] A multiplier 42 multiplies the envelope waveform signals input from the envelope generator 43 to the waveform signals of musical sounds, which are input from the Wave generator circuit 40. This assigns the predetermined envelopes to their waveform signals.

[0040] A filter circuit 44 performs predetermined filter calculations for the waveform signals of musical sounds to modify the

structure of their harmonics. This changes the structure, resulting in tone changes. The legato coefficient leg is also input to the filter circuit 44. This coefficient changes filter cutoff frequencies and Q.

[0041] In the embodiment above, a legato coefficient leg is calculated based on the characteristic of the waveform indicating the changes of the swing speed of the baton 20. A gate time, velocity, vibrato, filter coefficient, etc. are controlled using the coefficient. Alternatively, however, a gripper sensor 26 (refer to the broken line in FIG. 4), such as a pressure sensor or variable resistor, may be provided to the gripper of the baton 20 for controlling musical expressions based on the output of the sensor. More specifically, the output value of the sensor, instead of the legato coefficient leg, is input to the automatic play unit 22 and sound generator circuit 23. This adds further musical expressions to the musical sounds produced by swinging the baton 20 with emotion (gripping it strongly, for example).

[0042] In this embodiment, one or more sensors may be provided with the swing control element 1 including the baton 20. Multiple sensors may be provided on each finger. Furthermore, multiple types of sensors may also be used in parallel. A sensor output may be used to control one or more musical sound parameters. It is also possible to utilize these sensors in combination with the control by the character extraction of swing waveforms as described in the first embodiment.

[0043] The combination of microcomputers and software may be an alternative for each of the circuit in the embodiment above. In the embodiment, tempos of automatic playing are controlled with musical expressions based on the swing waveforms or sensor outputs. In another method, tempos can be specified, with the use of the baton20, for manual players (others) of keyboards and other instruments, while other musical expressions of the playing are controlled based on the swing waveforms or sensor outputs.

[0044] Furthermore, when combining with the automatic play unit, the control of the invention may be only applied to some of multiple data tracks for automatic playing.

[0045]

[Effects of the Invention] The invention as claimed in Claim 1 controls musical sound parameters based on the characteristic of waveforms. This enables musical expressions matching the eswing movement of a swing control.

[0046] The invention as claimed in Claim 2 can control tempos of automatic playing and musical expressions by the swing of a swing control element. This realizes automatic playing controls similar to the performance of a conductor.

[0047] The invention as claimed in Claim 3 can control tempos of automatic playing by the swing of a swing control element. Simultaneously, the hand holding the tool can control musical sound parameters.

[Brief Description of the Drawings]

FIG. 1 shows the structure of the invention as claimed in Claim 1.

FIG. 2 shows the structure of the invention as claimed in Claim 2.

FIG. 3 shows the structure of the invention as claimed in Claim 3.

FIG. 4 shows the structure of an automatic play system of an embodiment of the invention.

FIG. 5 is a block diagram of an automatic play unit used for the automatic play system.

FIG. 6 is a block diagram of a sound generator circuit used for the automatic play system.

FIG. 7 shows the changes of swing speed of a baton used for the automatic play system.

FIG. 8 shows the examples of swing patterns of the baton.

FIG. 9 is a flowchart illustrating the operations of the microcomputer used for the automatic play system.

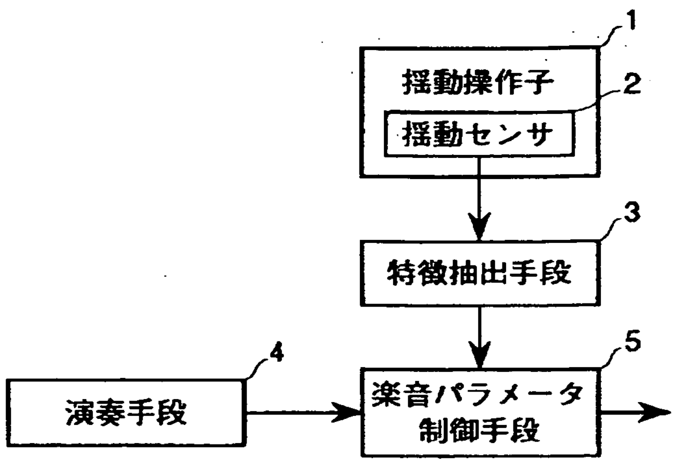
FIG. 10 is a flowchart illustrating the operations of the microcomputer used for the automatic play system.

[Description of the Reference Numerals]

1: swing control element, 2: swing sensor, 3: characteristic extracting means, 4: playing means, 5: musical sound parameter controlling means, 6: beat timing detecting means, 7: tempo controlling means, 8: automatic playing means, 9: gripper sensor, 20: baton, 21: microcomputer, 22: automatic play unit, 23: sound generator circuit, 24: digital-to-analog (D/A) converter, 25: sound system, 26: gripper sensor, 30: tempo control circuit, 31: play data memory, 32: reading circuit, 33: gate time

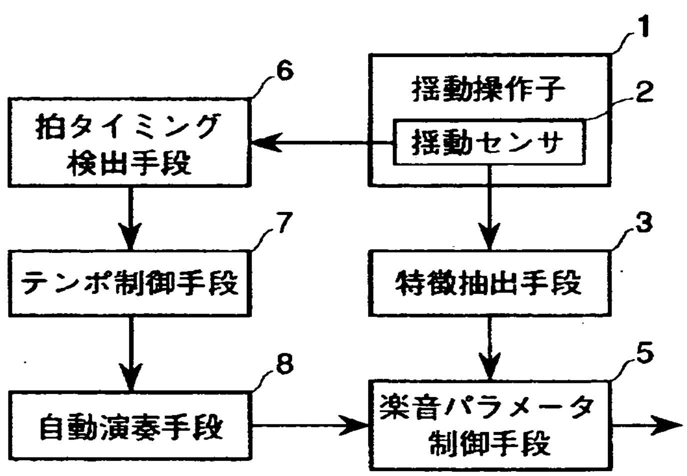
correction circuit, 34: volume correction circuit, 40: Wave generator circuit, 41: modulator circuit, 42: multiplier, 43: envelop generator, 44: filter

[FIG. 1]



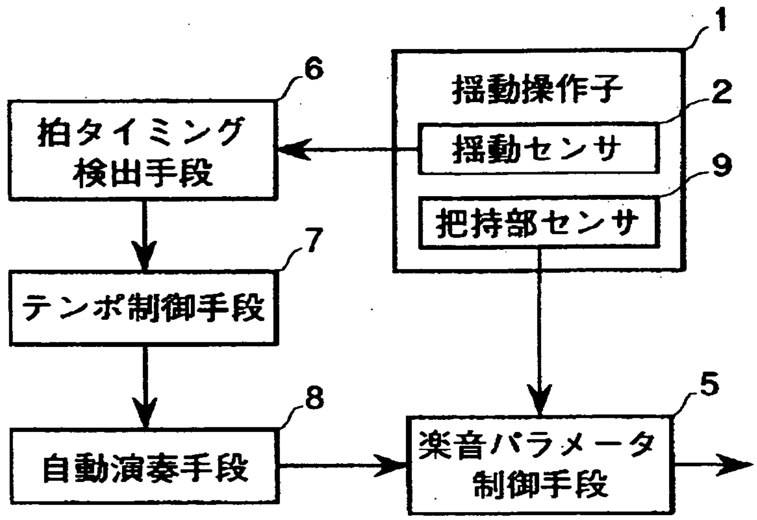
1 Swing control
2 Swing sensor
3 Characteristic extracting means
4 Playing means
5 Musical sound parameter controlling means

[FIG. 2]



1 Swing control
2 Swing sensor
3 Characteristic extracting means
5 Musical sound parameter controlling means
6 Beat timing detecting means
7 Tempo controlling means
8 Automatic playing means

[FIG. 3]



1 Swing control

2 Swing sensor

5 Musical sound parameter controlling means

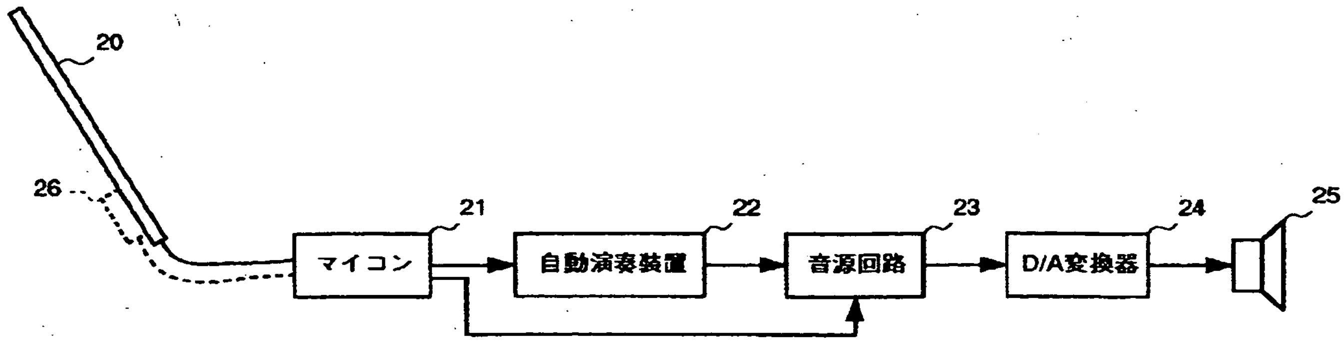
6 Beat timing detecting means

7 Tempo controlling means

8 Automatic playing means

9 Gripper sensor

[FIG. 4]



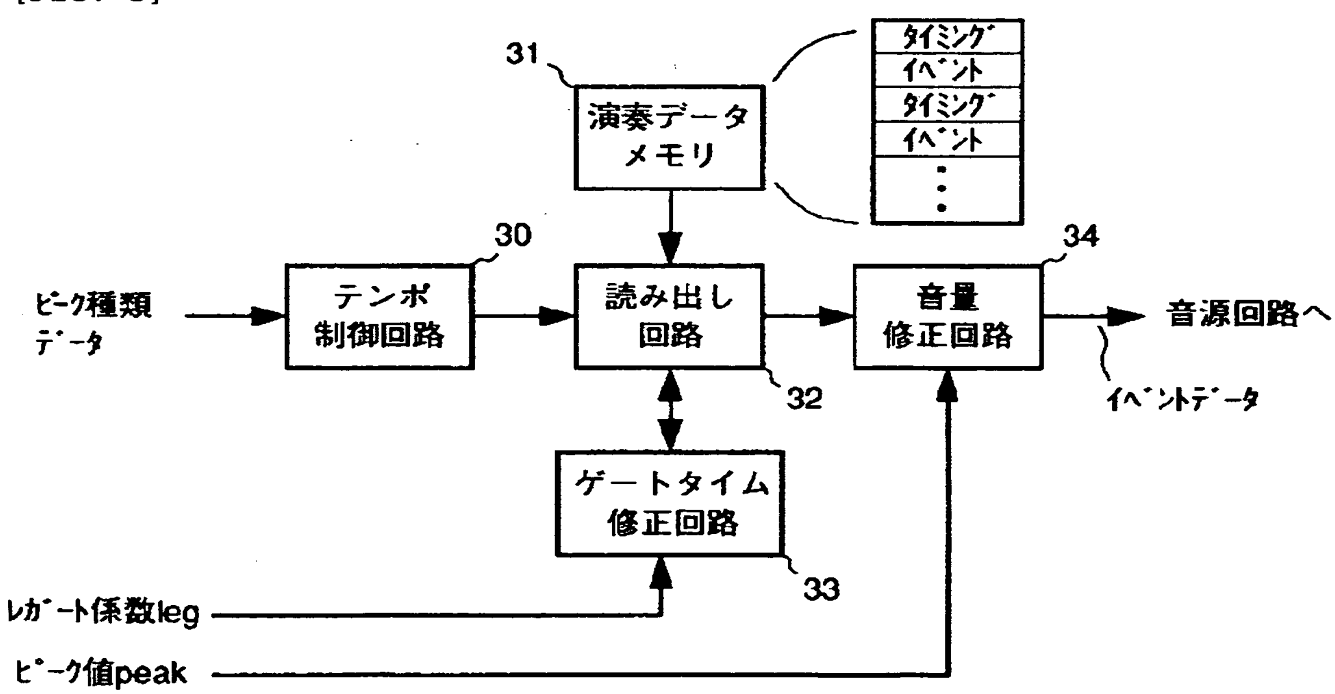
21 Microcomputer

22 Automatic playing unit

23 Sound generator circuit

24 D/A converter

[FIG. 5]



Peak type data

Legato coefficient leg

Peak value

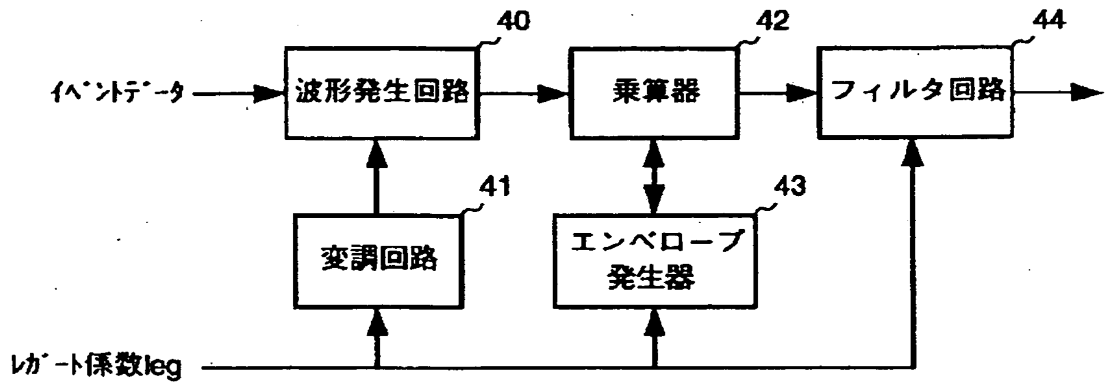
30 Tempo control circuit

31 Play data memory

32 Reading circuit

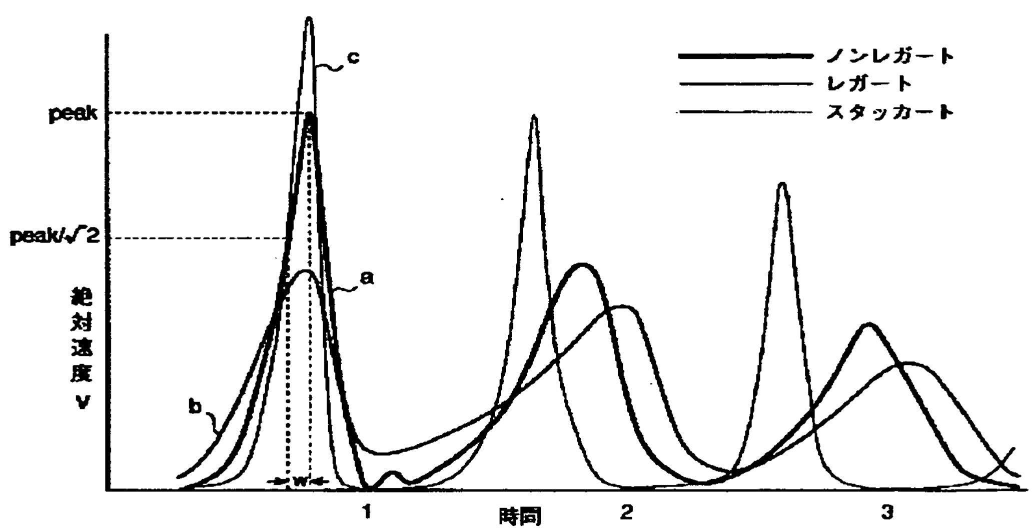
33 Gate time correction circuit
34 Volume correction circuit
Timing
Event
Event data
To sound generator circuit

[FIG. 6]



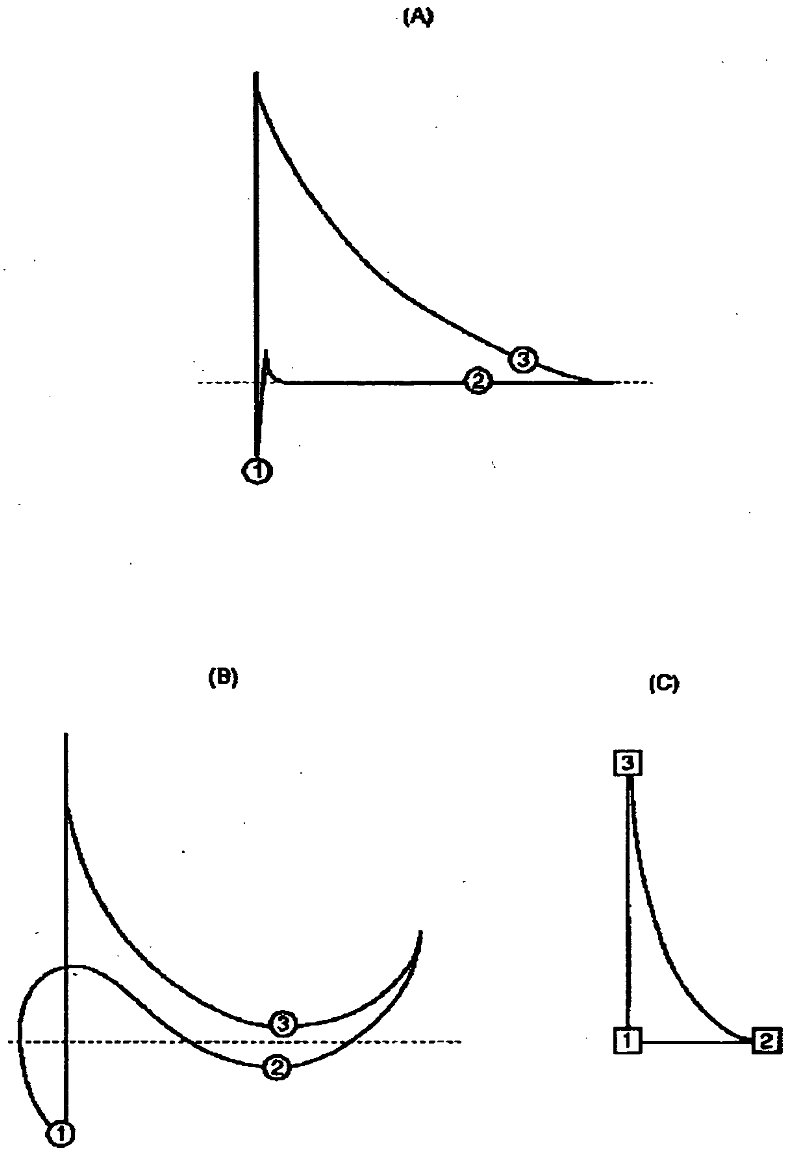
Event data
Legato coefficient leg
40 Wave generator circuit
41 Modulator circuit
42 Multiplier
43 Envelop generator
44 Filter circuit

[FIG. 7]

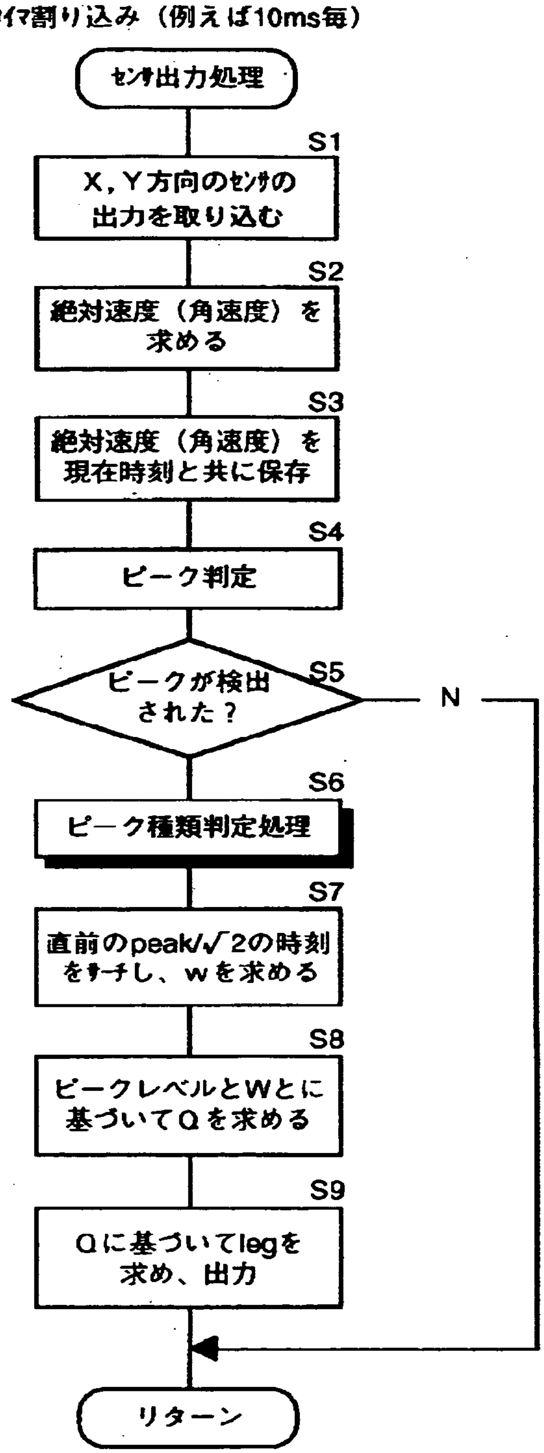


Absolute speed v
Non-legato
Legato
Staccato
Time

[FIG. 8]



[FIG. 9]



Timer interrupt (every 10ms for example)

s1

Loading the outputs of the sensors in the X and Y directions.

s2

Acquiring an absolute speed (absolute angular speed).

s3

Restoring the absolute speed (absolute angular speed) with the current time.

s4

Determination of a peak.

s5

Is a peak detected?

No

s6

A process for determining the peak type.

s7

Searching the time, at which an adjacent peak value is divided by the square root of 2, to acquire w.

s8

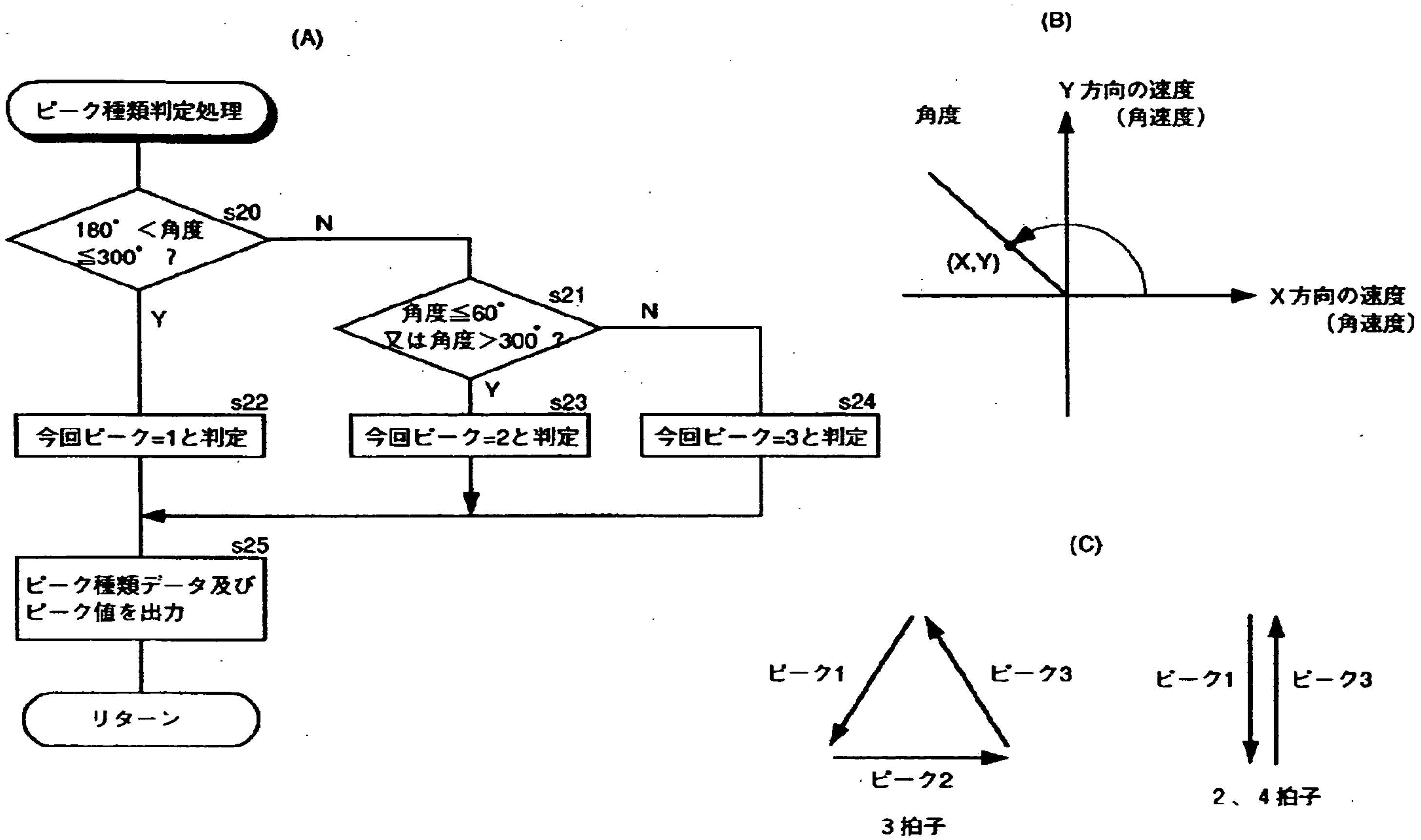
Acquiring Q based on the peak level and w

S9

Acquiring a leg based on the Q for its output.

Return

[FIG. 10]



(A)

A process for determining a peak type.

s20

180□<Angle≦360□?

Yes

No

s21

Angle ≦60□ or Angle>300□?

s22

Determining that the peak of this time is 1.

s23

Determining that the peak of this time is 2.

s24

Determining that the peak of this time is 3.

s25

Outputting the peak type data and its peak value.

Return

(B)
Angle
Speed in the Y direction (angular speed)
Speed in the X direction (angular speed)

(C)
Peak 1
Peak 3
Peak 2
Triple measure

Peak 1
Peak 3
Binary and quadruple measures